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Measuring Catches in the Carolina Headboat Fishery

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ABSTRACT

Two methods of measuring daily catches by headboats that fish the outer Continental Shelf off North Carolina and South Carolina are compared. Headboats are those commercial fishing boats where recreational anglers pay for a day's fishing on a per person, thus per head, basis. A dockside creel census estimated catches as only 47% to 87% of the catches, in numbers of fish, reported by crew members in logbooks. While the comparison suggests substantial bias in one or both techniques, low cost favors use of logbooks.

A valuable recreational fishery for tropical and subtropical deepwater fishes exists on the outer Continental Shelf of the South Atlantic states (Huntsman 1976). In 1972, the Beaufort Laboratory, National Marine Fisheries Service initiated a study of this fishery from Cape Hatteras, North Carolina to Charleston, South Carolina. In 1976 it was expanded southward to Cape Canaveral, Florida. Since headboats[1] are responsible for most of the catch, a major part of the study was the estimation of catch and effort in the headboat fishery.

There are several major problems in estimating catches of individual species. Only a few hours between the time a vessel heads homeward and the dispersion of anglers upon docking are available for examining catches. Generally catches are not sold, so records of transfer are not available. Landings are made at irregular intervals and at widely scattered points making it expensive to examine all catches. Because a majority of the anglers cannot identify the species caught, mail and telephone surveys are of limited value.

From 1972 through 1975 the catch of any headboat on a given day was obtained from logbooks maintained by mates of the vessels (Huntsman 1976). Because the accuracy of the logbook estimates had never been verified, we met several vessels at the dock in 1975 for purposes of estimating the catch for a vessel-day by a simple creel-survey technique.

In this paper we discuss the relative merits and costs of the logbook and creel-survey methods for estimating the fish landed by a headboat. We wish to emphasize that we were able to compare the two methods only to each other, and not to the true catches, which were, for various reasons, unknown.

METHODS

The logbook estimate of catch was obtained from the mate of each vessel. He was asked to record for each day of fishing, the date, vessel name, number of anglers aboard, location fished, number of each species caught, and the total weight of each species. He was provided log sheets listing all species likely to be taken and was paid $1.50 for each daily record.

The creel-survey method of estimating catch was a two-step procedure. When the vessel docked, a creel clerk asked every third person leaving the vessel, beginning randomly from the first to the third, if he had caught any fish. This sample was used to estimate the fraction of anglers that had caught fish on that trip.

The creel clerk then examined as many stringers as possible, recording the number of each species on each stringer and the number of anglers contributing fish to each stringer. A stringer in this study refers to a cord on which fish are attached as they are caught, or more rarely, an individual ice chest in which the fish are stored aboard the headboat. Occasionally several anglers combined their catches on a single stringer.

The stringer estimate of the j^{th} vessel's catch (in numbers) of the i^{th} species on the k^{th} day was:

$$C_{ijk} = P_{jk}N_{jk}C^*_{ijk};$$

[1] Headboats are those commercial fishing boats where recreational anglers pay for a day's fishing on a per person, thus per head, basis.

P_{jk} = the fraction of anglers that were successful on the j^{th} vessel on the k^{th} day;
N_{jk} = total number of anglers on the j^{th} boat on the k^{th} day;
C^*_{ijk} = average catch per successful angler of the i^{th} species on the j^{th} boat on the k^{th} day;
i = 1, . . . m; j = 1, 2, 3; and k = 1, . . . n.

Hereafter, catch will refer to numbers of fish rather than weight. Catches estimated by the first method will be referred to as logbook estimates, and catches estimated by the second method will be referred to as stringer estimates.

Both logbook and stringer estimates were obtained for three headboats for six fishing trips, making a total of 18 pairs of observations. To help reduce the variation due to seasonal changes, estimates were grouped in time (Table 1). That is, if catch was estimated for one of the vessels, it was also estimated for the other two within a 48-hour period. The estimates for the three vessels within a 48-hour period then constituted a block of observations in the analyses to follow.

The three vessels selected for inclusion in the study were from three different North Carolina ports. They were not selected at random, but rather were selected because their mates were dependable in maintaining the logbook records.

Estimates obtained from the two methods were compared, using analyses of variance in which the two measurements of a species catch were compared within dates and vessels. The analyses of variance were calculated for the following model:

$$C_{ijk} = \mu + B_i + V_j + \delta_{ij} + E_k + (VE)_{jk} + \epsilon_{ijk};$$

C_{ijk} = catch in numbers of fish;
μ = overall mean catch per headboat;
B_i = an effect due to the i^{th} sample period (block);
V_j = an effect due to the j^{th} vessel;
E_k = an effect due to the k^{th} estimation procedure;
$(VE)_{jk}$ = vessel × estimation procedure interaction;
δ_{ij} and ϵ_{ijk} = normally and independently distributed random components having zero means and associated with whole units and subunits respectively.

Vessels and estimation procedures were both considered fixed for the purpose of deriving expected mean squares for hypothesis testing.

A separate analysis of variance was calculated for red porgy (*Pagrus pagrus*), vermilion snapper (*Rhomboplites aurorubens*), red snapper (*Lutjanus campechanus*, *L. vivanus*, and *L. buccanella*, in aggregate), and groupers (*Mycteroperca* spp. and *Epinephelus* spp. in aggregate). A fifth analysis of variance was based on the total catch of all species, including those in the previous four analyses, but not limited to them. Because F_{max} tests (Sokal and Rohlf 1969) indicated heteroscedasticity, the data were transformed to square roots before proceeding with the analyses.

RESULTS

Because there was no evidence of interaction between the catch estimation procedure and vessel effect in any of the five analyses, the main effects for estimation procedure were tested (Table 2). Logbook estimates were significantly higher (α = 0.05) than stringer estimates for the vermilion snapper and for the red porgy, as well as for all species combined. While there were also significant differences among vessels for their catches of some species, such differences are not germane to this study.

It is clear from an examination of the average catches (Table 3) that significant differences among the two catch estimation methods were only detected for those species or species groups that were relatively abundant in the catch. This in turn suggests that if groupers and red snappers had been caught in greater numbers, significant differences between the two types of estimates for those species would probably have been detected. The magnitude of the difference between the two estimates was directly pro-

TABLE 1.—*Source data for analysis of variance comparing estimation methods.*

Observation	Block[a]	Vessel	Estimate type[b]	Catch estimates: numbers/headboat: All species	Grouper	Red snapper	Vermilion snapper	Red porgy
1	1	1	1	558	37	0	175	180
2	1	1	2	406	10	13	251	67
3	1	2	1	360	38	3	35	180
4	1	2	2	208	57	3	13	118
5	1	3	1	456	31	3	0	225
6	1	3	2	230	15	1	0	109
7	2	1	1	718	22	0	463	156
8	2	1	2	380	165	0	154	204
9	2	2	1	336	21	0	20	150
10	2	2	2	216	28	2	11	109
11	2	3	1	353	0	0	75	150
12	2	3	2	157	0	3	6	66
13	3	1	1	514	35	0	200	141
14	3	1	2	423	8	0	32	8
15	3	2	1	336	38	0	12	150
16	3	2	2	103	14	2	2	71
17	3	3	1	675	30	0	120	300
18	3	3	2	171	0	0	17	100
19	4	1	1	347	24	0	78	150
20	4	1	2	452	16	0	43	314
21	4	2	1	633	32	0	0	300
22	4	2	2	148	18	0	0	83
23	4	3	1	413	38	0	100	175
24	4	3	2	311	0	0	40	181
25	5	1	1	426	1	0	94	158
26	5	1	2	236	0	8	92	64
27	5	2	1	447	14	3	0	60
28	5	2	2	252	2	8	0	223
29	5	3	1	126	18	3	0	100
30	5	3	2	74	2	4	0	63
31	6	1	1	510	5	0	120	73
32	6	1	2	365	5	0	72	20
33	6	2	1	512	7	50	30	250
34	6	2	2	320	3	10	17	265
35	6	3	1	392	32	0	100	150
36	6	3	2	277	27	0	0	145

[a] Block 1—June 17, 1976; 2—June 24, 1976; 3—July 15, 1976; 4—July 22, 1976; 5—August 12, 1976; 6—August 18,1976.
[b] Estimate 1 = logbook estimate; estimate 2 = stringer estimate.

portional to the abundance of the species or species group in the catch.

DISCUSSION

A major limitation of this study is that actual catches were not known thereby making it impossible to tell which estimation technique was more accurate. We assume that the stringer estimates were generally more accurate than the logbook estimates because the stringer estimation procedure was more rigorously prescribed, but that remains to be verified by further research.

We could have obtained complete counts by placing our own personnel aboard the vessels for the entire fishing day, but the

TABLE 2.—*Analyses of variance based on the square roots of estimated catches for five species-groupings of fish. Asterisks show significance at* $P < 0.05^*$ *and* $P < 0.01^{**}$.

Source	df	Mean squares: Groupers	Red snappers	Vermilion snapper	Red porgy	Total catch
Sampling date	5	8.3642	4.1253	20.1290	10.4984	12.8628
Vessel	2	5.5390	5.3327	261.6192**	10.2604	58.2835
Error a	10	10.1662	2.6729	19.9454	13.3807	14.3574
Estimation procedure (E.P.)	1	12.8688	1.6546	76.5552**	48.4488*	239.6494**
Vessel × E.P.	2	6.1179	0.9645	9.3202	2.2645	9.7517
Error b	15	4.4255	1.2640	6.3580	10.7807	6.4720

TABLE 3.—*Mean landings (numbers of fish per headboat) for two estimation procedures.*

Groupers	Mate estimate	Stringer estimate	Ratio Stringer/ mate
Groupers	23.6	20.5	0.87
Red snappers	3.4	3.0	0.88
Vermilion snapper	89.6	41.7	0.47
Red porgy	168.8	122.8	0.73
Total catch[a]	452.3	262.7	0.58

[a] Includes all species taken by anglers.

expense precluded that approach. Furthermore, the presence of biologists might well have altered responses of the mates and perhaps would have jeopardized their cooperative attitude by giving the impression that we were checking on them.

A possible problem with our study was that the criterion used to select vessels may have led to an inaccurate assessment of the quality of logbook estimates. If a positive relationship exists between the accuracy of logbook estimates and the regularity of record keeping, selection of vessels known to be faithful in maintenance of logbooks caused an optimistic appraisal of logbook estimate validity.

The California Department of Fish and Game has used catch logs to document partyboat (headboat) catches since 1936 (Young 1969). An examination of 587 landings from 1947 through 1951, showed that catch logs reported 103.7% of the actual catch (determined by count) (Baxter and Young 1953). In some instances, however, substantial inaccuracies were discovered; logbook counts ranged from 56% to 152% of the true catch of other species and chub mackerel (*Scomber japonicus*), respectively.

The California investigations are not directly comparable to ours because a report of catch is required by California law and submission of accurate reports bears on availability of a state license to operate a partyboat. Thus, the law exerts considerable pressure towards good record keeping. In addition, the California partyboats were landing about 100 fish per trip, whereas the North Carolina headboats were landing approximately 300 fish per trip. As we have seen, the discrepancy between the logbook estimate and the stringer estimate is proportional to the size of the catch.

For some types of fishery analysis, adjustment of logbook estimates should not be necessary even if they are biased; e.g., descriptions of trends in catch per unit of effort, and analyses of catch curves. Adjustment of biased estimates would of course be necessary for yield computations and for comparison with commercial catch statistics. The relatively consistent relationship between the two types of estimates should provide straightforward means of adjusting the catches when necessary. For practical purposes, although the ratios of logbook estimates to stringer estimates vary by species, we suggest that true catches are probably best estimated by 0.6 (the estimated ratio for all species) of the logbook estimate (Table 3).

In comparing the two techniques we noted that the stringer estimate employs a clearly specified sampling procedure and has the advantage of not relying on the cooperation of vessel mates, who are usually cordial and cooperative, but sometimes antagonistic, or dishonest. Stringer estimates can be more completely controlled by us and incorporated into sampling designs for the fishery. On the other hand, stringer estimates cost much more than corresponding logbook estimates and are feasible only when fish are available for inspection at dockside. When, as is often the case, fish are already iced in coolers when the headboat docks, or anglers do not linger at the dock, counts are difficult.

Logbook estimates offer extensive but inexpensive coverage of headboat fishing activity. We currently obtain records on over half of all headboat trips each season at a cost less than that for covering 3% of all trips by stringer count. Because of the great variability between trips, extensive coverage of the fishery appears necessary. We believe we will obtain a better measure of catches of uncommon fishes from the logbook estimates than from the stringer counts because anglers often ask mates to identify unusual fish. Another advantage is the relative ease with which we can integrate the logbook estimate of catch with logbook information on effort and fishing locations. After balancing costs and benefits we have decided to continue monitoring headboat catches with logbook records, even though they are apparently biased.

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